Richard W. Hamming

Learning to Learn

The Art of Doing Science and Engineering

Session 8: Artificial Intelligence III

Topic Outline

Question: Can Machines Think?

Some Perspectives

Open Discussion

Question: Can Machines Think?

Goal is to think about this question, not to give answers.

Common observations:

- "I would never have my life depend on a machine!"
- "I do not want machines to control my life!"
- "Machines can never do things humans can do!"

- **It is the combination of human and computer that is important.**

Question: Can Machines Think?

Advantages of computers over humans:

- Economics, speed, accuracy, reliability, rapidity of control, freedom from boredom, bandwidth in and out, ease of retraining, hostile environments, personnel problems

- **It is the combination of human and computer that is important.**
- **The surer you are of one side of the argument, the more you should probably argue the other side!**

Perspectives

- Maybe computers have not yet been programmed to think because programmers are stupid!
- Just because you want to believe machines can think doesn't mean they can.
- Just because you want to think machines cannot think doesn't mean they can't.
- Computer programs can learn from experience (e.g., Samuels' checker program).
- Isosceles triangle theorem proving showed "originality."

Perspectives

- Imagine the shortest program that could think – no component of it could think.
- Consider “logical” and “psychological” novelty.
- Whatever your opinion, what evidence would you accept to indicate you are wrong?
- Thinking may be a matter of degree and not a yes/no answer.
- Thinking may be the *way* something is done rather than *what* is done.

Discussion Point 1

Student

- Computers cannot think – it takes a thinking individual to write a program to simulate thinking. A computer is not capable of creative thought.
- Cannot identify every situation and come up with a move.

Hamming

- What about Samuels' checker-playing program – did it learn?

Discussion Point 2

Student

- A computers cannot think – it is limited by its programming, but as programs become more and more complex, it gives the illusion of thinking.
- Chess/checkers programs analyze the board and make a move based on best probability of success.
- Do we have a creative spark that computers do not have?

Discussion Point 3

Student

- We learn through repetition.
- Computers will only think as well as its program performs.
- A computer doesn’t think, it just executes.

Discussion Point 4

Student

- Checkers world is a 2-dimensional board with limited number of decisions and limited sensory input. Can write a program to deal with this and to “think.”
- If you could provide a computer with enough input to emulate human perceptions, then you could potentially write a computer program that could think.
- Not likely in near future, but possible.

Discussion Point 5

Student

- Start with question, “What is thinking?” It is the ability to ask questions! Questions are based on a need – what does a computer need?
- On this premise, a computer cannot think because it cannot pose questions to search for answers.
- Regarding limits, I realize I have limits but can a computer realize it has limits? A computer does not have self-awareness.

Discussion Point 6

Student

- Computer operates within whatever paradigms the programmer has given it. Computer cannot operate outside these paradigms, but humans have that creative ability.

Hamming

- What about child development through learning? Are we different than computers?

Discussion Point 7

Student

- New question: Do we want machines to think? I say no, because then they will become just as unreliable as people!
- What we want is to be able to control machines and not allow them to think.

Hamming

- Very good point, yet AI wants to get machines to do what we cannot. Can they in the long run?

Discussion Point 8

Student

- "Thought" evolved as a survival tool. It is a procedure:
  - *Perception of the environment (ability to sense)*
  - *Anticipate a change in the environment (recognize pattern, imagine/create internal environment)*
  - *Derive an appropriate behavior to account for that change (develop appropriate response; projecting likelihood of success of action)*
- Thinking is a continuum of abilities.
- From this perspective, a machine can think.

Hamming on Creativity

- Regarding creativity to construct something like the theory of relativity – when you look closely, the person was led little by little to the result.
- Einstein – as a child had asked himself questions about traveling at the speed of light.
- Creativity is not the “light bulb going on” but much more of a deliberate process, much of it subconscious.

Discussion Point 9

Student (revisits earlier comments)

- Chess program thinks within the limited environment of the chess game.
- Consider a fish in a fish bowl – it thinks and makes choices in its environment, but its brain is limited just as the chess program is limited.

Discussion Point 10

Student

- Humans can daydream and imagine, computers cannot.

Discussion Point 11

Student

- Define thinking as the ability to deviate from the standard program or paradigm.
- So, could a computer be classified as thinking if it has deviated from its original programming?
  - *Wouldn't the deviation also have been programmed into the computer?*
  - *Humans also – could the deviation even be something programmed into us at a deeper level?*

Discussion Point 12

Student

- From the dictionary, to “think” is to “exercise of powers of judgment, conception, or inference.”
- Computers and humans operate by a set of rules, but humans have difficulty expressing what the rules are that they operate by.
- Humans also operate on the basis of concepts – just having the general idea instead of a set of rules.

Discussion Point 13

Student

- Regarding rules, can use neural networks and genetic algorithms to enable machines to learn (e.g, flight controller).
- The program can even adapt to new circumstances very rapidly.

Discussion Point 14

Student

- Machines, even Marines, can think.
- What machines cannot do is *feel*. If a chess program wins a game, is it glad that it won?
- Generally, what we consider thinking is applying what we know to solve a problem. Machines are no different.

Discussion Point 15

Student

- Prefer the word “intelligence” to “thinking.”
- Intelligence at its most basic level is being aware of ones surroundings. Computers can do this.
- Thinking is the ability to take the perceptions and put them together into a logical result or to compute something. Computers can do this.
- Distinguish “being smart” from “common sense.”
- Overall intelligence is the sum of all of these. Computers currently lack this ability because we are limited in our ability to program them.
- The question is driven by human arrogance!

Discussion Point 16

Student

- Thinking is related to the broader issue of good and evil. We can’t program feelings into machines.
- Humans are unique in their capacity to love and to hate.

Hamming

- There was a story of a robot that killed a person…
- What if a computer had the same sensory experience as humans? Could it then do better than humans?
- Machines can make other machines.

Discussion Point 17

Student

- Machines making other machines – is that tasking or reproducibility?
  - *When machines make other machines, we know the outcome.*
  - *When humans reproduce, we do not know the full characteristics of the baby.*

Hamming

- We can program machines to be random. We've just typically programmed them to do exactly what we want them to do.

Discussion Point 18

Student

- How do you program a machine with morality?
- There are as many opinions about what is moral as there are students in the room.

Discussion Point 19

Student

- Human is a biological engine – DNA executes its code that makes processes inside the mind happen.
- Similar for computers – processor, memory, instructions.
- We now have software objects reacting to other software objects. We will see programs processing software at one level, but at a higher level there will be objects interacting with other objects within and across machines.
  - *And agents talking to agents in the Semantic Web!*
- Morality, creative thought, and intuition are being applied in a human sense – computers will have their own definitions for these concepts.

Discussion Point 20

Student

- Regarding morality, machines operate in a black and white world. Humans make judgments.
- Perhaps computers have an advantage over us in this regard.
- Would be interesting exercise for each individual to try to write rules for behavior in different situations.

Discussion Point 21

Student

- The real test is what a computer can learn and do on its own.
- Computer can be very good at acquiring information but it cannot acquire understanding of what it perceives. Does not ask “why?”
- We are motivated to ask “why?” so we have evolved to discover things we do not observe.

Discussion Point 22

Student

- Are computers really thinking or just simulating thinking?
- Perhaps a chess master thinks on some different level than the computer chess-playing program.
- Can possibly write a program to have the computer ask “Can a computer think?” but it wouldn’t be the computer asking the question; it would be the program.

Hamming

- There are times when a teacher feels a class is only simulating intelligence!

Discussion Point 23

Student

- What's to stop a computer from learning to write its own programs?
- Today, we write the programs. If a computer can write code and learn, might it evolve much faster than we did?

Related topics

Semantic Web

- http://www.w3.org/2001/sw/

Blending and Conceptual Integration – beginnings of a computational model for the way we think?

- http://blending.stanford.edu
- See The Way We Think: Conceptual Blending and the Mind's Hidden Complexities by Gilles Fauconnier and Mark Turner